FLOW TRANSMITTERS

AW COMPANY

ELECTRONICS FOR INSTRUMENTATION

EMO-500

Operation Manual rev.4



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EMO 500 MANUAL TABLE OF CONTENTS

Overview of Display Screens

The 0 through 9, and F1 keys display these screens except when programming.

Key	Display	Description
0-KEY = = =>	RATIOA/B = 1.19 W=Y A=N I = 1.00	= = =>Current Ratio A/B = = =>Warning, Alarm, Ideal Ratio
1-KEY = = =>	FLW A=139.3 CCM FLW B=136.3 CCM	= = = > Flow A = = = > Flow B
2-KEY = = =>	JOB A=10779. CC JOB B=11703. CC	= = = > Job Total A = = = > Job Total B
3-KEY = = =>	GR A=300912. CC GR B=313391. CC	= = = > Grand Total A = = = > Grand Total B
4-KEY = = =>	J A+B 614303. CC G A+B 623476. CC	= = = > Job Total (A+B) = = = > Grand Total (A+B)
5-KEY = = =>	CURRENT RATIO LI WAR=005%ALA=010%	= = = >Ratio Warning/Alarm Settings ANo Ratio Mode@ when Limit 2 Rule is not on Ratio
6-KEY = = =>	SD1: AO=0000 IN=11111OUT=0000	= = = >Analog Out, 0-4095 = 0-20mA = = = >Inputs pins 1-5, Limits Out
7-KEY = = =>	SD2:FA=139FB=136 TA=10779TB=11793	= = = >Frequency A, B .....(Hz) = = = >Total Impulses A, B
8-KEY = = =>	RATIO A/B=1.19 FL A+B 275.6 CCM	= = = >Current Ratio A/B = = = >Flow Rate (A+B)
9-KEY = = =>	L1 L2 L3 L4 OFF OFF ON ON	= = = >Limit Status
F1-KEY ===>	T A-B= 24321. CC F A-B= 15.4CCM	= = = >Total Differences = = = >Flow Differences

Introduction

The EMO-500 is a Two Component Ratio and Flow Computer. It is primarily designed for use as a two component, ratio monitoring unit but can also be used as a Two Channel Flow Rate Monitor and Totalizer. The EMO 500 has the added capability of current (4-20mA) and voltage (0-5V) analog output signals. These outputs can be used as a representation of a selectable range of functions or in a ratio linked, closed loop mode - Ratio Feedback Mode.

The unit is powered by 110V AC but can be jumpered for 220V AC.

The back panel provides these features:

< 18V supply plus ground and input lines for two flow meters.

< 4 programmable relay switched limits which can be used for warnings, alarms, or automatic shut-down control.

< 5 "Ready to Hardwire" function controls. #'s 1 through 4 allow for remote operation of resets, display, and Quick Programming. # 5 will "enable" the main programming menu.

< RS-232 and RS-485 serial ports.

< Analog outputs (4 - 20mA) and (0 - 5V).

Programming functions are shown in red on the keypad.

All of the default program variables can be changed to alternative values through the keypad or by a host computer with an RS-232 serial port. There are security features to prevent unintended programming changes - for more information review the pages on **Quick Programming** and **Full Programming**. The Quick Programming functions allocated to certain keys are indicated in red on the keypad. Keys F1 through F6 have multiple functions and are also used for the main programming purposes. The alternative function of each key when in Full Programming Mode is indicated by a banner on the keypad immediately above these specific keys.

When programming is not enabled the F3/F4/F5 serve as Job Resets and keys 0 through9 are used to select from the 11 operating displays shown on page 1.

The higher flow side should be connected to
flow meter A as the Ratio calculation is A/B
IMPORTANT----IMPORTANT----IMPORTANT----IMPORTANT

Special Features of the EMO-500

The EMO 500 is especially suited for use in dispensing systems with irregular flow patterns. The unit employs a user programmable sampling size to govern how often the ratio display is updated - the operator then has maximum control over the sampling period and can easily adjust this to suit his own system parameters. The user is often more interested in the ratio of components dispensed over a period of time, say in a batch, rather than on an instantaneous basis.

Programming

< There are 3 methods of programming the unit - two have lockout features to prevent unauthorized access.

Full Programming Enable:

< The full programming menu is accessible by placing a jumper between pin 5 (enable programming) and pin 6 (Common). The F2 key will page through the menu of programming options - these options are indicated in red lettering on a banner above the upper function keys.* See Programming the EMO 500 (Pg.8).

Quick Programming Feature:

< Some variables only need to be installed once. With others, such as Gate Time or Sample Time, the user may wish to experiment to find a preferred value. To make this easier or make some selected variables permanently available, such selected programming functions are accessible in the following way:

Simultaneously - Engage the 'Scroll Display' (jump pin #2 to #6) and press one key on the upper line, F1 through key #1. Note -The variable is highlighted in red on the key. Press Enter (F6) to exit. (Pg.17).

Serial Port Programming:

< The EMO-500 is fully programmable through the serial port using RS-232 or RS-485 type communication. Refer to the Serial Port Operations portion of this manual for complete information.

Sample Size - # of impulses collected for the Ratio Calculation.

< To determine the **ratio -** the total number of pulses from both flow meters are separately counted until one of them reaches the programmed Sample Size. The number of pulses from flow meter A is then divided by the number of pulses from flow meter B. The governor will therefore be the meter with the slower pulse rate. The Sample Size determines both the accuracy and response time of the **ratio calculation -** reducing the sample size, increases the response time but decreases the accuracy. A default value of 200 is factory installed. See P.

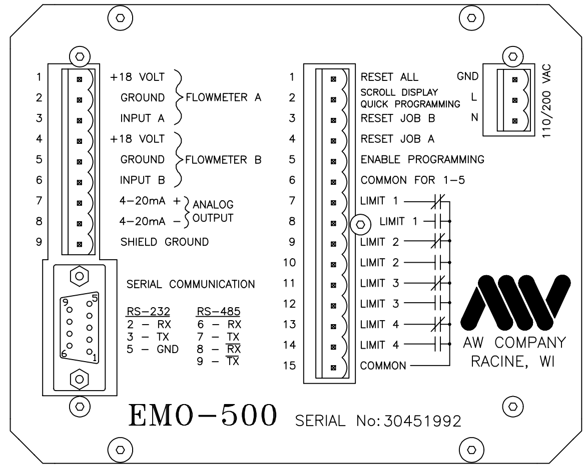
Gate Time - Time period over which Rate Calculations are made.

< The gate time (in seconds) is the time period the microprocessor collects pulses to perform rate calculations. A default value of 1.85 is factory installed. See P.15.

Hardware Connections

Warning: The AC Power should be wired just as labeled on the three pin connector.

PIN 1-Ground
PIN 2-Line 110v.
PIN 3-Line Neutral



Grounding Considerations

The grounding is a most important consideration in an installation where microprocessor technology is applied. The EMO-500 is a panel mounted unit and therefore the casing is connected to the sub-panel. If the sub-panel is metal it should be grounded. If the sub-panel is non-conductive - PIN 1 of the three pin connector on the EMO-500 back panel must be grounded.

To insure a proper ground we recommend connecting PIN 1 of the three pin connector to the panel's central ground point.

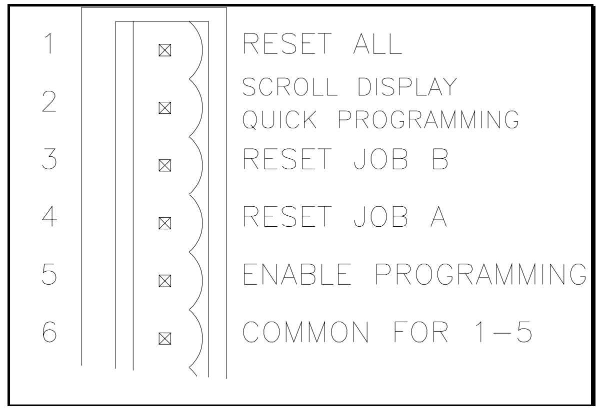
Signal and Shielding

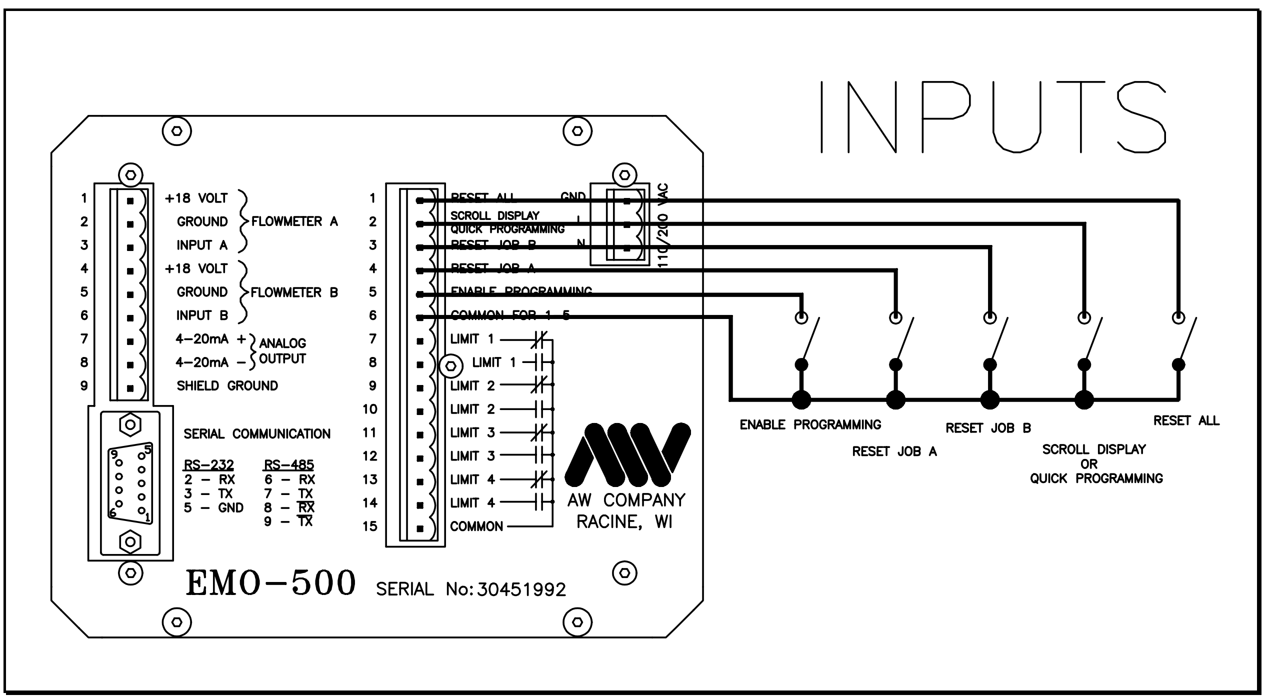
The two flow meter pick-ups should be supplied with their respective 18v. supply voltages and referenced to their respective grounds. This will insure that the input signals from the flow meters are referenced to the ground connections on pins 2 and 5. Most applications require some signal shielding. A solid aluminum wrap shielding will work fine. The shield should be connected to pins 2 and 5 on the flow meter connector. **DO NOT connect the shielding at the flow transmitter.**

IMPORTANT! NEVER CONNECT THE SHIELD TO GROUND AT BOTH ENDS!! DOING SO CAN PRODUCE UNWANTED OSCILLATIONS IN THE SIGNAL WIRES.

Hardware for External Resets and Controls

There are 5 inputs to the 15 pin connector to provide extra control capability without having to go through the keyboard. To activate the external resets and controls the user should simply connect the respective pin to the common 1 - 5 pin. Pins 1 - 4 are edge triggered, therefore momentary contact switches should be used to activate them. Pin 5 (enable programming) is an on/off function and single pole toggle switch is recommended.





External Resets and Controls

1. **Reset All**

This reset is the most powerful on the EMO 500.
When activated it will reset:

Ratio : A/B
Job Vol A, Job Vol B & Job Vol A+B
Warning & Alarm Limits
Limits 3 & 4
Grand Totals
Analog Outputs to start point

2. **Scroll Display**

When activated, this input will scroll the display through all of the 11 screens available. It also allows access to the Quick Programming functions which are highlighted in red on the upper keypad line. (See pg 8. for more details on Quick Programming).

3. **Reset Job B - resets OFF-RATIO WARNING/ALARM (LIMIT 1 & 2).**

When activated, this input will reset the Job B totalizer. This also resets the A/B RATIO to the IDEAL setting, which simultaneously resets the WARNING & ALARM LIMITS.

4. **Reset Job A - resets OFF-RATIO WARNING/ALARM (LIMIT 1 & 2).**

When activated this input will reset the Job A total. This also resets the A/B RATIO to the IDEAL setting, which simultaneously resets the WARNING & ALARM LIMITS.

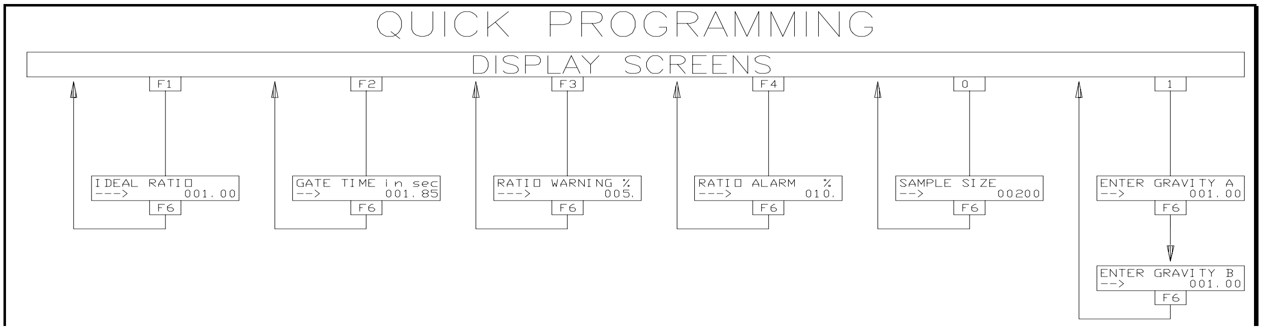
Note: Simultaneously pressing and holding RESET JOB A and RESET JOB B on the keyboard, or through the back-panel connections, implements a HOLD TOTAL function.

5. **Enable Full Programming**.

When activated, this input enables the F2 through F6 keys to perform the programming functions shown in red on the banner strip above the keypad.

NOTE: F3, F4, F5 will serve as Job Resets in the Job Totals screen when the Enable Programming switch is off.

The Quick Program Options



While many programming variables such as KFR or meter selection may only require a "one time" setting - others may require some experimentation to find maximum efficiency settings. It may also prove desirable to allow an operator in the field some limited ability to make some quick adjustments. To accommodate these circumstances a method of jumping directly into some limited programming functions has been made available. This method is called "Quick Programming" The functions available are noted in red on the top line of keys -F1-F6 Function Keys & 0-1 keys.

F1 .... Ideal Ratio

F2 .... Gate Time

F3 .... Ratio Warning %

F4 .... Ratio Alarm %

F5 .... Decimal Point

F6 .... Enter

0 .... Sample Size

1 .... Specific Gravity

To activate a Quick Programming Option.

Connect the Scroll Line Input (Pin 2) and the Common 1 - 5 (Pin 6) of the 15 Pin connector on the back panel of the EMO 500 -a momentary contact switch is recommended. While this connection is made, simultaneously push any one of the keys shown above. NOTE: This will not work if full programming is enabled.

***NOTE See Appendix D for a circuit drawing.**

F1 Ratio Default Value = 1.00

This function is the address of the IDEAL RATIO which represents the desired ratio of FLOW A/FLOW B. The default is 1.00 which represents a 1 to 1 ratio.

F2 Gate Time Default Value = 1.85

The GATE TIME is the period of time, in seconds, during which the flow rate calculation is made. The accuracy and response time of the flow rate display is therefore dependent upon this value. To achieve a 1% accuracy, the slowest pulse rate should deliver at least 100 pulses.

F3 Warning Default Value = 5%

The WARNING variable is available to set as a % deviation from the Ideal Ratio. The ratio calculation is triggered by the first meter to deliver the number of pulses programmed under the SAMPLE AMOUNT variable. The calculation compares the measured ratio to the Ideal Ratio and if the difference in % terms exceeds the programmed value, the warning is activated.

F4 Alarm Default Value = 10%

The ALARM variable is similar to the warning function.

F5 DP Decimal Point

This key is used to locate the decimal point when programming.

F6 Enter

Locks in programmed values.

#0 Sample Size Default = 200

To determine the ratio the total number of pulses from both flowmeters are separately counted until the fastest one reaches the programmed SAMPLE SIZE. The number of pulses produced by flowmeter A is then divided by flowmeter B, and the result determines the ratio calculation. The accuracy and response time of the ratio calculation are therefore dependent upon the SAMPLE SIZE. The flowmeter with the lowest pulse rate should produce 100 pulses before the ratio calculation is updated to achieve a "1% accuracy. The display screen #7 is an useful guide for this purpose.

#1 SG Default = 1.0

Specific gravity values may be entered for each metered flow should quick corrections be required in this value.

Programming the EMO 500

As a security precaution, access to the full programming section is only possible when pin 5 is "enabled". This can be accomplished by connecting pin 5, on the 15 pin connector, to the pin 6 Common (See Appendix D). Next, after first hitting F2, each function key, F1 through F6, will then allow access to the programming menu indicated immediately above it on the red banner strip (The banner strip is labeled 'PROGRAMMING' as indicated below).

ESCAPE	ACCESS	RATIO	LIMITS	METERS	GLOBALS	PROGRAMMING

IMPORTANT ACCESS IS DENIED TO F3, F4 & F5 UNTIL F2 IS PRESSED FIRST. THIS IS A SECURITY MEASURE TO PREVENT UNINTENTIONAL PROGRAMMING CHANGES

Reminder Note: The other programming functions, indicated in red, on the F1 - F6 and 0 - 1 keys are activated by the Quick Programming Options which are reviewed on page 8. (Quick Programming is provided for immediate access to a few limited programming functions only).

AFTER JUMPERING PIN 5 TO PIN 6 - THE ACCESS SEQUENCE IS AS FOLLOWS:

MAIN MENU

F2

OPTIONS

F3	F4	F5	F6
RATIO PRG.	**LIMIT PRG.**	**METER/UNIT PRG.**	**GLOBALS PRG.**

Enable Prog. --> F2	-->	F3	...	(Access to Ratio Prog)
	-->	F4	...	(Access to Limit Prog)
	-->	F5	...	(Access to Meter/Units)
	-->	F6	...	(Access to Global Prog)

The **F1** key serves as an **ESCAPE** key to leave the programming functions and return to the last screen displayed.

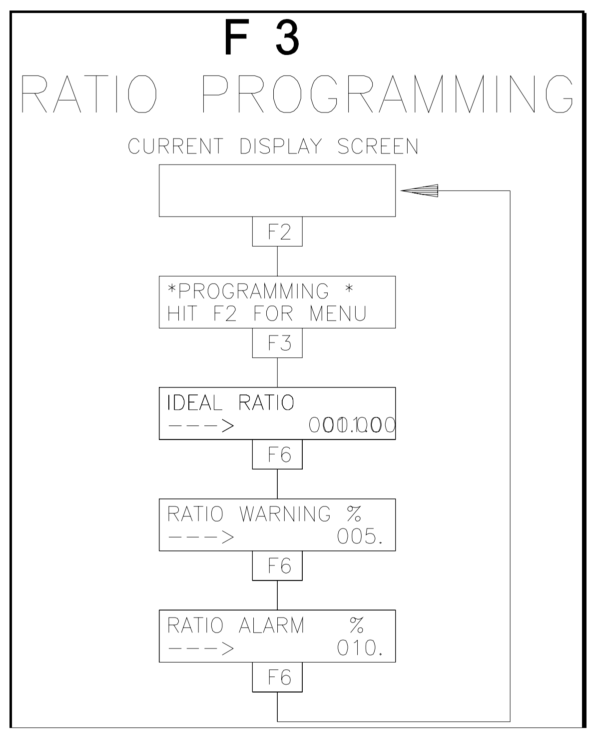
The **F2** key will page the user through the programming options shown above **AND IS REQUIRED TO ALLOW FURTHER ACCESS.**

The **F3** key will call up **Ratio Programming.**

< Enter the Ideal Ratio. This number represents the desired Ratio of Flow Amount A to Flow Amount B. The default is 1.00, meaning a 1 to 1 ratio.

< Enter the Ratio Warning. This number represents the percentage of error between the actual measured ratio and the desired ideal ratio. The default is 5%. Therefore, if the actual and measured ratio differ by more than 5%, the Limit 1 relay will close.

< Enter the Ratio Alarm. This number works the same as Ratio Warning except that after the warning, the EMO 500 will wait for one more sample amount before closing the Limit 2 Relay if the ratio error is greater than the programmed percentage. The default is 10%.



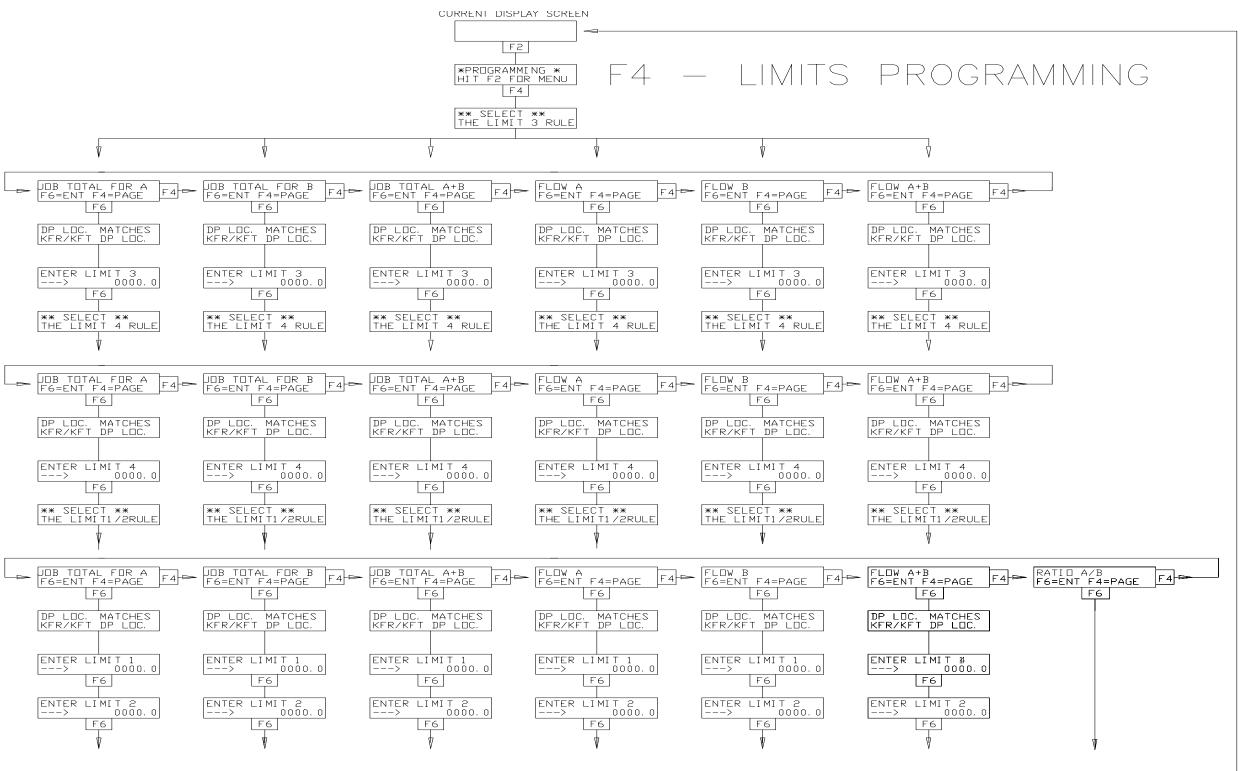
The **F4** key will call up **Limit Programming.**

OFF-RATIO WARNING & ALARM SETTINGS

Since the EMO 500 is primarily a Ratio Monitor, Limits 1 and 2 are factory set to be triggered by an off-ratio condition.

Default values are set at Limit 1 = Warning 5% and Limit 2 = Alarm 10%.

For example: If the RATIO WARNING is programmed at +/- 10%, then the LIMIT 1 contact will close when this event occurs. LIMIT 2 will be similarly activated by the value programmed in the RATIO ALARM. Note - Press key #5 to review the current ratio alarm settings and key #9 to review the limit status. Off-ratio alarms can be reset easily by pressing either F3 (Reset A) or F4 (Reset B).



As mentioned previously, Limits 1 & 2 are preset for ratio alarms and are very easily adjusted for different ratio settings via the Quick Programming.

Limits 3 & 4 can be used to warn of other monitored parameters such as flow rates or totalized fluid volumes. These settings can be adjusted as follows.

There are three parts to the full Limit Programming section and each part should be done in order. They are:

1. Limit 3 Rule & value
2. Limit 4 Rule & value
3. Limit **2** Rule and or value

This procedure is also shown pictorially on the previous page.

First you must enter the "Limit 3 Rule". This means the user must select the function wanted to trigger the Limit 3 relay. The options are:

- Job Total for A - Flow A
- Job Total for B - Flow B
- Job Total for A+B - Flow A+B

Page through the options above by pressing F4, enter using F6.

The numeric value at which the Limit 3 Relay will trip should now be entered. This number will work with the Limit 3 Rule selected above.

NOTE: The display will flash "DP Location Will Match KFT/KFR".
This means that the number entered for the Limit trip point will automatically take the same decimal point location as the Total Scaling Factor (KFT) for Total Limits or Rate Scaling Factor (KFR)for Flow Rate Limits.

Type in the **Limit 3 value** desired and enter with F6

The limit 3 number must be entered to proceed to Limit 4

The **Limit 4 Rule** and **Number** entry is exactly the same as above.

The limit 4 number must be entered to proceed to Limit **2**

Next the Limit **2** Rule can be entered.

< **If the user selects Ratio A/B the Limits 1 and 2 will operate on the ratio percentage of error under F3 Ratio Programming.** Therefore, if Ratio A/B is selected **-** limit programming is complete. The unit will exit to the last display in memory before entering the programming mode.

For example - Limit 1 & 2 can be programmed for Warning & Alarm settings on Flow A while Limit 3 & 4 could be allocated to Warning & Alarm for Flow B or Flow A+B and Total B respectively. Therefore Limits 3 and 4 can be selected independently but 1 & 2 cannot be separated.

Therefore, if Ratio A/B is selected under the Limit **2** rule, the limit programming is complete. The unit will exit to the last display in memory before entering the programming mode.

Other options are as follows: Page using F4 and Enter, F6.

- Ratio A/B	
- Job Total for A	- Flow A
- Job Total for B	- Flow B
- Job Total for A+B	- Flow A+B

NOTE: If the user selects any function other than Ratio A/B for the Limit 2 Rule, the EMO 500 will still monitor the ratio of flow A/B, but no Warning or Alarm will trip when flow is out of the programmed error percentages. This will be indicated in display 5 as " NO RATIO MODE FOR LIMITS 1 & 2 ".

The **F5** key will call up **Meters/Units Programming**

< In this program section the user can select from 9 Flow Meters and 3 Engineering Units. The EMO 500 will automatically enter the Rate Scaling Factors (KFR) and Total Scaling Factors (KFT) for each of the selections below.

Flow Meters and their approximate K-factors

- ZHM01..160000 PPG	- ZHM03...6600 PPG	- HPM-15..32000 PPG
- ZHM02/1.32000 PPG	- ZHM04...1800 PPG	- HPM-20..16000 PPG
- ZHM02...16000 PPG	- ZHM05....500 PPG	- HPM-30...6600 PPG

When in the Meters/Units Program, scroll through the Meters until the selection desired appears on the display. Then enter with the F6 key. The unit will then ask the user to select the Engineering Units in the same manner.

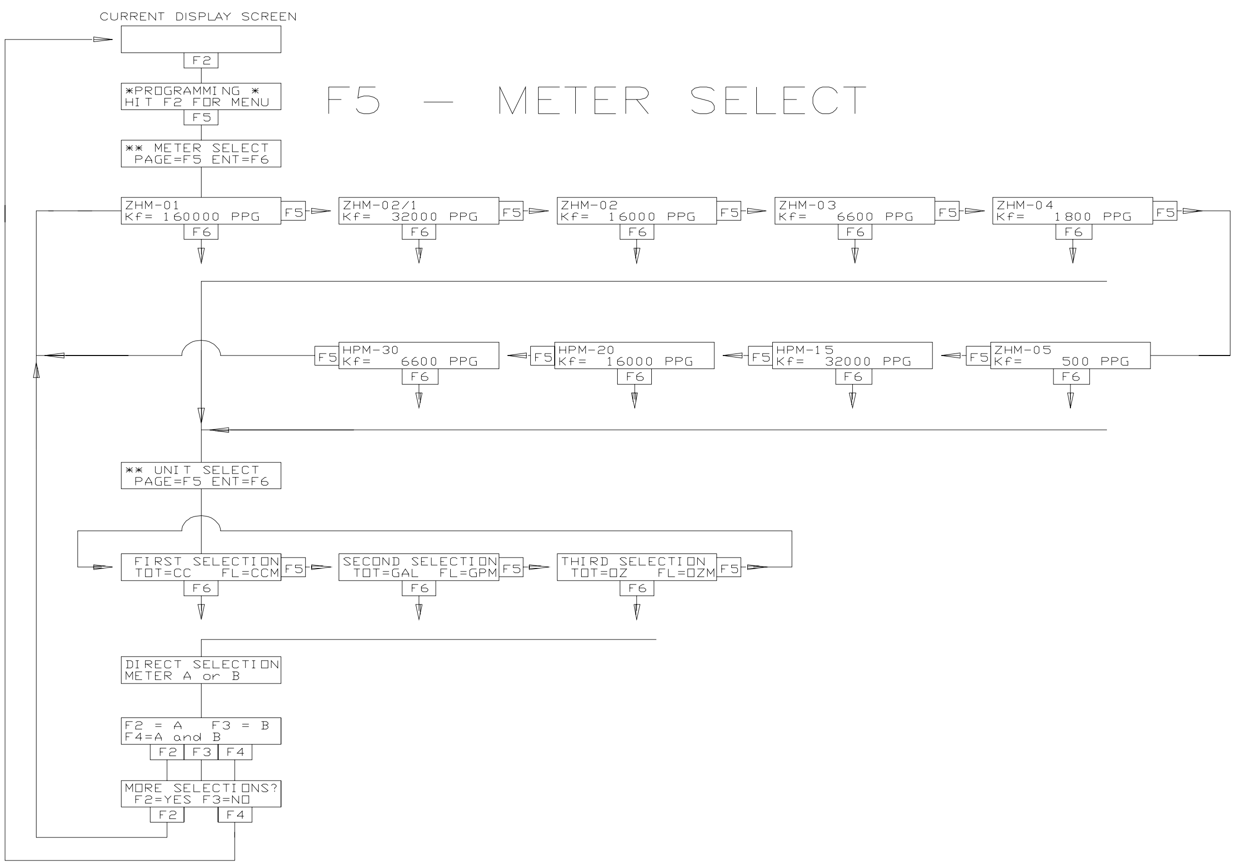
Engineering Units

- CC & CCPM - GAL & GPM - OZ & OZM

The EMO 500 will flash "Direct Selection, Meter A or B" then the display will read "F2=A, F3=B, F4=A&B". This is where the user can choose the input the selected Flow Meter and Engineering Unit will be set. The display will the read "More Selections?, F2=Yes, F3=No". If both Flow Meters are programmed select F3, if not F2 will start the Meters/Units Program section again.

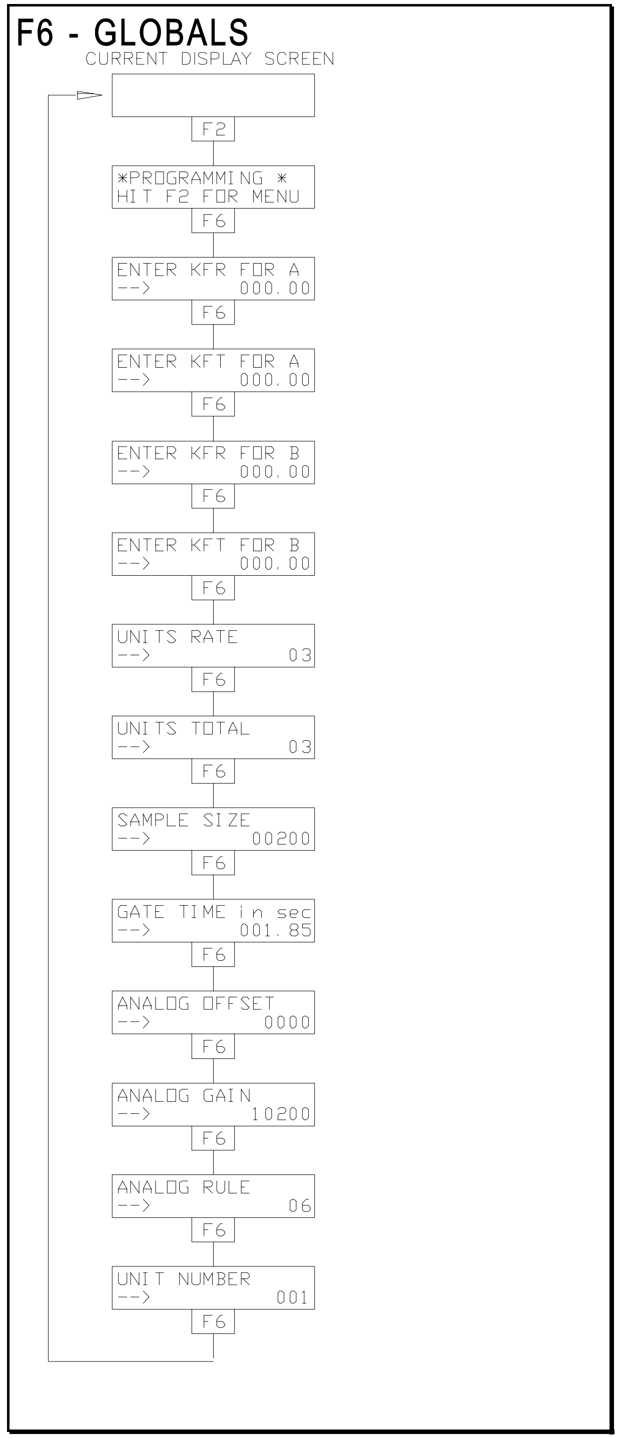
NOTE: The Engineering Units for A and B should be the same.

NOTE: The (KFR) and (KFT) values in the Meters/Units Programming are only approximations because the K-factors of the above flow meters are only approximations. The user should calculate the (KFR) and (KFT) using the calibrated K-factor whenever possible. This will be covered in the Global Programming section.



F6 key will call up **Global Programming.**

	Global Default Values		
1.	KFR for A	-----------	100.0
2.	KFT for A	-----------	10000
3.	KFR for B	-----------	100.0
4.	KFT for B	-----------	10000
5.	Units for Rate	-----------	12 Hz
6.	Units for Total	-----------	08 Impulses
7.	Sample Size	-----------	200 Impulses
8.	Gate Time	-----------	1.85seconds
9.	Analog Offset	-----------	0000
10.	Analog Gain	-----------	10200
11.	Analog Rule	-----------	06 Ratio
12.	Unit Number	-----------	01



EXPLANATIONS OF THE GLOBAL VARIABLES

1. KFR for A.....Default 100.0

In order to make the EMO 500 display the correct rate in an engineering unit such as GPM, a scaling factor must be calculated. This Rate Scaling Factor is called the KFR. The KFR is calculated using the K-factor of the flow transmitter being monitored. **The K-factor is the number of impulses per engineering unit established by a calibration test.**

For example: A flow meter could have a K-factor of 6304 imp/Gal. In order to calculate the KFR multiplier for the EMO 500 apply the following formula:

$$KFR = \frac{6000}{\text{K-factor}}$$

100 is the constant for seconds
6000 is the constant for minutes
360000 is the constant for hours

This KFR is the number that should be entered in the Globals Programming section. The K-factor is the number published by the manufacturer as the average K-factor for the transmitter.

For Example: A flow meter has the K-factor 2053.7 imp/GAL and the display should show Gallons/minute.

$$KFR = \frac{6000}{2053.7} = 2.921 \text{ GPM}$$

The number 2921 would be entered as the respective KFR and the DP (decimal point) key would move the DP to the number 2.921.

NOTE: We recommend removing the insignificant decimal numbers often produced by calculator mathematics. These present a misleading level of precision in the display. **We recommend using a maximum of 4 digits regardless of the decimal point position.**

Example: for 60.675 enter 60.67
for 2.3456 enter 2.346

NOTE: The largest number that can be entered as a KFR is 65000 ignoring the decimal point position. Therefore 7.3456 will fail to be accepted as too large. A message will alert the user if this should occur.

2. KFT for A ....Default 10000

In order to make the EMO 500 display the correct Totalized Value in Engineering Units, again the most important thing to know is the K-factor of the flow meter. The K-factor is the relationship between the amount of the impulses and the engineering units.

In order to calculate the KFT for the EMO 500 apply the following formula.

$$KFT = \frac{10000}{\text{K-factor}}$$

The KFT is the number that should be entered in the Globals Programming section. The K-factor is the number published by the manufacturer as the average K-factor of the flow meter. If this is published in imp/Gal the totalizer can still be set in, say cc's , by converting the K-factor to imp/cc. 10000 is a constant.

For example: A flow meter has a K-factor of 106666.0 imp/Gal and the display should show gallons/minute.

$$KFT = \frac{10000}{10666.0} \quad = .9376 \text{ Gal}$$

The number 9376 would be entered as the KFT and then the DP (decimal point) key would move the DP to 0.937. (See note below).

NOTE: We recommend removing the insignificant decimal numbers often produced by calculator mathematics. These are mathematically redundant and offer a misleading level of precision in the display. We recommend using a maximum of 4 digits regardless of the decimal point.

Example: for 60.675, enter 60.6
for 2.34543 enter 2.345

NOTE:

< **The largest number that can be entered as a KFT is 65000. Refer to KFR note above.**

3. KFR for B The operations are the same as **KFR for A.**

4. KFT for B The operations are the same as **KFT for A.**

5. Units for Rate.

This variable will display the Engineering Units required for the flow rate display. This is strictly a display and does not perform the actual conversion of raw counted impulses. Those calculations are handled by the KFR. Enter the two digit number for the desired Units for Rate.

00 - cc/min	06 - gram/sec
01 - liter/min	07 - lb/min
02 - gallon/min	08 - Kg/min
03 - ounce/min	09 - Kg/sec
04 - RPM	10 - lb/sec
05 - gram/min	11 - lb/Hr
	12 - Hz (Impulses/sec)

6. Enter Units for Total.

This variable will determine the Engineering Units for Total displayed after the totalizer value. It is also a display function only and doesn't perform the actual conversion of total impulses to the correct value. Those calculations are handled by the KFT.

Enter the two digit number for the desired Units for Total.

00 - cc	04 - revolution
01 - liter	05 - gram
02 - gallon	06 - lb
03 - ounce	07 - kg
	08 - Impulses

7. Sample Size...Default 200

To determine the ratio the total number of pulses from both flow meters are separately counted until one of them reaches the programmed Sample Size. The number of pulses from flow meter A is then divided by the number of pulses received from flow meter B. **The accuracy and response time of the ratio calculation are therefore dependent on the Sample Size**.

To determine a reasonable number to program for Sample Size the main factor will be the flow meter with the lowest pulse rate should produce at least 100 pulses before the Ratio calculation. If 100 pulses are counted on the slowest moving totalizer then the accuracy of the ratio calculation should be about " 1 %.

NOTE: **The pulses being counted are straight from the flow meter, not scaled engineering unit values.**

The display screen #7 (Status Disp. 2) is a useful guide in this selection. The lower line shows the incoming raw pulse count. If the Sample Amount is say 1000, the ratio display will update each time the fastest total increments by 1000. Also by this method, the slower pulse count can be observed. **The default value is 200**

8. Gate Time .... Default 1.85 sec.

The gate time (in seconds) is the amount of time pulses are accepted before flow rate calculations are performed. The accuracy and response time of the flow rate display are dependent on the gate time. To achieve a 1% flow rate accuracy, the lowest pulse rate should produce 100 pulses before the rate calculation is performed. In display #7 (Status Display 2) the lower line indicates incoming flow meter impulses, an estimate of the time elapsed for 100 pulses, to be accumulated by the slowest meter, will give a good approximation of the minimum recommended gate time.

Another method would be to change the default Gate Time value by trial and error until the best results for the system and user are achieved.

9. Analog Offset..Default 0000

The Analog Output Offset will be a number from 0000-4095 that will become the bottom end of the 0 - 5 volt & 4 - 20 mAmp analog outputs.

For example:	0000	for 0 to	20mAmps	and 0 to 5v.
	819	for 4 to	20mAmps	and 1 to 5v.
	1638	for 8 to	20mAmps	and 2 to 5v.
	2457	for 12 to	20mAmps	and 3 to 5v.

10. Analog Gain...Default 10200

The analog gain factor integrates the controller output signal range and speed with the rest of the system capabilities. If the gain factor is correct the full range of the analog output signal can be used to cover the operating range of the equipment in which it is installed.

The formula used to determine the analog output is as follows:

$$\textbf{Analog Output} = \frac{\textbf{(Variable Value) * Gain}}{\textbf{512}}$$

The Analog Output arrived at above should be a number from 0000-4095 which drives a D/A converter for a 4 - 20 mAmp and a 0 - 5 volt output on Pins 7 and 8 of the 9 Pin connector. Therefore the gain factor can be estimated by re-arranging the analog output equation as follows:

$$\textbf{GAIN} = \frac{\textbf{(512)(Analog Out)}}{\textbf{Variable Value}}$$

If the desired max output of the system is achieved at 5V or 20 mAmp - this is equivalent to an Analog Out value of 4095 and the above equation would read:

$$\textbf{GAIN} = \frac{\textbf{(512)(4095)}}{\textbf{Variable Value}}$$

The "Variable Value" is the true flow rate or volume capability of the system measured at the analog value discussed above and will therefore depend upon the ANALOG RULE selected. The Analog Rule is discussed further on the next page.

NOTE: The value entered ignores the decimal point position.

For Example:

In Ratio Mode (06)

If Ideal Ratio = 5.00..Variable Value = 500
If Ideal Ratio = 10.00..Variable Value = 1000

In Flow Mode (00-02)

If Flow Rate = 80.0 cc/m ....Variable Value = 800
" " " = 200.0 cc/m ....Variable Value = 2000
" " " = 5.25 GPM ....Variable Value = 525

In Flow Mode (03-05)

If Total Flow = 10.00 Gal...Variable Value = 1000

11. Analog Rule   Default 06

The analog rule allows the user to set the analog output to follow any of the variables listed below. The variable is selected by entering its number as the Analog Rule.

These are:

00 - Flow A	06 - Ratio
01 - Flow B	07 - Ratio Feedback Mode
02 - Flow A+B	08 - Ratio w/Reset
03 - Total A	09 - Ratio Feedback w/Reset
04 - Total B	10 - A - B Job Total
05 - Total A+B	11 - A - B Flow Rate

NOTE: These variables will be used in the computations as numbers in Engineering Units.(ccpm,gals,ozs.etc.) This means that the Decimal Points, if any, will be dropped from the numbers.

For instance: 113.7ccpm will be 1137 for computations.

12. Unit Number..Default 001

This Variable is used for Serial Communication with a host computer. It will identify each EMO 500 unit if there is more than one on the communication line. For example - Unit #1 would be designated 01 & unit #2, 02 ....etc.

DEFAULT VALUES THROUGHOUT THE EMO 500

Ratio Programming

Ideal Ratio 1.00

Ratio Warning 5%

Ratio Alarm 10%

Limit Programming

Limit Rule 3 .... Job Total A

value 3000

Limit Rule 4 .... Job Total A

value 4000

Meters/Units Programming

Meter .... Hz

Units .... IMPULSES

Global Variables

KFR for A 100.0

KFT for A 10000

KFR for B 100.0

KFT for B 10000

Units Rate .... .12

Units Total 08

Sample Size 200

Gate Time 1.85

Analog Offset 0000

Analog Gain 10200

Analog Rule 06

Unit Number 01

EMO 500 - RATIO FEEDBACK MODE

The EMO 500 also features a Ratio Feedback Mode of operation in which the Ideal Ratio and the Actual Measured Ratio are compared and a 4-20 mA signal will be generated to control one of the Flow Rates. This will maintain the programmed Ideal Ratio over a wide range of flow rates.

The formula used to determine the correct analog output is as follows:

Analog Output = Half Range + (Ideal Ratio-Actual Ratio) * Gain

The **Half Range** refers to the middle point of the Analog Output. If the output varies from 0 to 20mAmp. the half point will be 10mAmp.. If the Analog Offset is set to give an output of 4 to 20mAmp. the Half Point will be 12mAmp.

To use the Ratio Feedback Mode the user should enter 07 as the **Analog Rule (See P.18)**.

NOTE: The Ratio Feedback Mode w/Reset works in exactly the same manner excepting that the analog output will go to the start point (mid-point) on Reset All input.

Serial Port Operations

The EMO 500 has RS-232 and RS-485 serial port connections standard on the back panel 9 Pin connector. The user can connect this port to a host computer and then Read or Write to any memory location in the EMO 500. The RS-232 Pins on the 9 Pin connector are:

Pin 3......TX transmit
Pin 2......RX receive
Pin 5......Ground

The RS-485 connections are:

Pin 6 ..... RX
Pin 7 ..... TX
Pin 8 ..... RX*
Pin 9 ..... TX*

WARNING --- IMPORTANT --- WARNING --- IMPORTANT

The communication port does not discriminate any addresses. This means that any address can be written to as well as read from. Writing to certain addresses will change the operation of the EMO 500 drastically. Caution is a must when programming through a host computer. Double Check Addresses and Variables Before Writing to the EMO 500 !!

Note: The communication through the serial port will not work if the EMO-500 is in programming mode

Protocol Format

The EMO 500 uses a protocol format follows OPTOMUX by the OPTO 22 Company.

The format for reading from the EMO 500 is as follows:

```
>01K0F3404XXcr
^................start of string must use the > sign
 ^^.............unit number (under global variables)
   ^.............read command K (use J to write)
    ^^^^......address to read from
        ^^......number of bytes to read
          ^^....checksum for the string 01K0F3404
            ......carriage return (ASCII 13) ends the string
```

The answer received back from the EMO 500 will look like this:

```
A03E36712XXcr
^...............all answers start with A
 ^^...........low byte (at address 0F34)
   ^^.........next byte(at address 0F35)
     ^^.......next byte(at address 0F36)
       ^^.....high byte(at address 0F37)
         ^^....checksum
           ......carriage return ends the string
```

The protocol format for writing to the EMO 500 is as follows:

```
>01J03340F3587XXcr
 ^.....................start of string must use the > sign
  ^^..................unit number
    ^..................write command J (use K to read)
     ^^^^...........address to write into
         ^^...........byte written to 0334
           ^^.........byte written to 0335
             ^^.......byte written to 0336
               ^^.....checksum
                   .....carriage return
```

If the operation was successful the EMO 500 answers with: Acr.

The following error messages have been implemented in the EMO 500 protocol.

NO1cr - Undefined command (something other than K/J)
NO2cr - Checksum error
NO3cr - Non printable ASCII character

There is a booklet published by OPTO 22 on the protocol format.

Checksum Calculation

The calculation for the string variables in the read command would be as follows:

```
>01K0F3404XXcr
 ^^^^^^^^^.......these characters are used in the calculation.
```

Add the values for the ASCII Decimal variables.

```
   HEX    0 +  1 +  K +  0 +  F +  3 +  4 +  0 +  4
 ASCII   48 + 49 + 75 + 48 + 70 + 51 + 52 + 48 + 52 = 493
```

To calculate the final checksum, convert the decimal number 493 into HEX (493=1EDh) and take the last two characters (ED) for the checksum.

The final string would look like this:

>01K0F3404EDcr

Important points for serial communication

1. Serial communication will be disabled if the EMO-500 is in programming mode.
2. All characters in the communication string should be in CAPITALS.
   Example: ›K: is ASCII 75 and will be recognized by the EMO-500, but ›k: is ASCII 107 and will not be recognized.
3. All numbers in the communication string are represented in hexadecimal format.
3. You should not try to read or write more than 12 bytes at a time due to limitations of the EMO-500's serial buffers.
4. The least significant byte of a number is stored at the lower address.
5. The ›>: in the transmit string and the ›A: in the reply string are not used in the checksum calculation.

The ASCII characters needed for checksum calculations are:

ASCII	Decimal	ASCII	Decimal
0	48	A	65
1	49	B	66
2	50	C	67
3	51	D	68
4	52	E	69
5	53	F	70
6	54		
7	55		
8	56	J	74
9	57	K	75

WARNING --- IMPORTANT --- WARNING --- IMPORTANT --- WARNING

The communication port does not discriminate any addresses. This means that any address can be written to as well as read from. Writing to certain addresses will change the operation of the EMO 500 drastically. Caution is a must !!! Double Check Addresses and Variables Before Writing to the EMO 500.

WARNING --- IMPORTANT --- WARNING --- IMPORTANT --- WARNING

The bytes are always arranged such that the low byte is first and the more significant bytes follow. In the EMO-500, the least significant byte (LSB) is at the lower address.

For example: If the data from the totalizer was read as
90D58901 the LSB is 90 and the MSB is 01.

The arrangement of these four bytes in the EMO-500 memory would be:

Address = 05A0H	05A1H	05A2H	05A3H
Vaule = 90H	D5H	89H	01H

And the totalizer value should be interpreted as:
0189D590H = 25,810,320 (in decimal)

ADDRESS INFORMATION

IMPORTANT

When writing to the EMO 500 there are always two locations to be changed for a permanent entry into the memory. This is because there are locations for data running currently in the RAM and there are locations for data that will be battery backed. **If the information has been written to the running locations alone it will be lost when the EMO 500 is turned off.**

Below is a QBASIC program that will allow the user to communicate with the EMO 500 by initiating serial port #1 and prompting for read and write strings. The strings must use the OPTO 22 protocol format described on page 18.

```
DEFINT A-Z
'* Serial Communication Test Program for OPTOMUX Code
'* For use with AW Company's EMO Series Flow Computers

'* Open serial port #1 to 9600 baud
OPEN "COM1:9600,N,8,1,RS,CS,DS,CD" FOR RANDOM AS #1
'* set up loop for transmitting several strings
CLS
DO
    PRINT "Enter String to send. (Press ENTER alone to END)"
    INPUT "Transmitting String: >", Transm$
    IF LEN(Transm$) = 0 THEN END
        '* Calculate Chksum
    Chk = 0
    FOR Char = 1 TO LEN(Transm$)
        Chk = Chk + ASC(MID$(Transm$, Char, 1))
    NEXT
    Chk$ = HEX$(Chk)
        '* Must be 2 characters, 1 byte
    IF LEN(Chk$) < 2 THEN Chk$ = "0" + Chk$
        '* Add the recognition character plus checksum
        '* use only the last byte of checksum
    Transm$ = ">" + Transm$ + RIGHT$(Chk$, 2)
        '* Send it to the EMO
    PRINT #1, ; Transm$; CHR$(13);
        '* Read what the EMO sending back
    LINE INPUT #1, Receive$
    PRINT "Received: "; Receive$
    PRINT
LOOP
```

WARNING --- IMPORTANT --- WARNING --- IMPORTANT --- WARNING

The communication port does not discriminate any addresses. This means that any address can be written to as well as read from. Writing to certain addresses will change the operation of the EMO 500 drastically. Caution is a must !!! Double Check Addresses and Variables Before Writing to the EMO 500.

WARNING --- IMPORTANT --- WARNING --- IMPORTANT --- WARNING

Running Address in HEX	Back-up Address in HEX	Bytes	Description	Default Value
05F5	0402	2	KFR A	1000
061A	0404	2	KFR A Decimal Pt.	01
0637	0412	2	KFR A Eng. Units	00
05FF	040A	2	KFT A	10000
061C	040C	2	KFT A Decimal Pt.	00
0639	0414	2	KFT A Eng. Units	00
05F7	0406	2	KFR B	1000
061E	0408	2	KFR B Decimal Pt.	01
063B	0416	2	KFR B Eng. Units	00
0601	040E	2	KFT B	10000
0620	0410	2	KFT B Decimal Pt.	00
063D	0418	2	KFT B Eng. Units	00
050A	042D	2	Limit 1 Value	1000
050C	042F	2	Limit 2 Value	2000
050E	0422	2	Limit 3 Value	3000
0510	0424	2	Limit 4 Value	4000
060B	042C	2	Limit 1 & 2 Rule	06
0604	0429	2	Limit 3 Rule	00
0605	042A	2	Limit 4 Rule	00
*0614 (4)	042	2	Ideal Ratio	100
0618	0420	2	Ratio Alarm	10
0622	041E	2	Ratio Warning	05
059D	0437	2	Analog Rule	06
05AA	0433	2	Analog Gain	102000
05B9	0431	2	Analog Offset	0000
0606	041A	2	Sample Size	200
*053D	041C	2	Gate Time	1.85
0626	042C	1	Unit Number	001
0516	read only	4	Flow A	xxxx
051A	read only	4	Flow B	xxxx
051E	read only	4	Flow A & B	xxxx
05B5	read only	4	Ratio A/B	xxxx
*05A0	read only	4	Job Total A (SD2)	xxxxxxxx
*05A6	read only	4	Job Total B (SD2)	xxxxxxxx
05EF	read only	4	Job Total A + B	xxxxxxxx
*052E	read only	4	Grand Total A	xxxxxxxx
*0533	read only	4	Grand Total B	xxxxxxxx
0504	read only	4	Grand Total A & B	xxxxxxxx
05A4	read only	2	Analog Out	xxx

* **These special variables indicated on the next page function in this manner.**

* Ideal Ratio- The largest number that can be written into the Ideal Ratio without an overflow is 640. Variable at address 0426h is 3 bytes, at 0614h is 4 bytes.

* Job Total A (SD2)- This variable will show twice the amount read from the Job A display. This is because the number is actually a raw count from the freq. input. The number read will match the totals seen in the Status Display 2 screen.

* Job Total B (SD2)- Same as above.

* Grand Total A- This variable will not be stored into the backup memory until the Job Volume A has been reset. Therefore the location will read zero until the count is stored away with the Reset Job A.

* Grand Total B- Same as above.

* Gate Time-This variable is a converted number because the keypad entry is made in seconds and a constant must be applied for computations. Therefore after reading the Gate Time the number read must be converted to decimal then divided by 5388 for an answer in seconds.

LIMITED WARRANTY

AW-Company warrants the EMO-500 Flow Computer to be in good working order for a period of 1 (one) year from the date of purchase from **AW-Company** or an Authorized **AW-Company** distributor. Should the EMO-500 fail to be good working order at any time during this 1 year warranty period, **AW-Company** will, at its option, repair or replace the EMO-500 at no additional change expect as set forth below. Repair parts and replacement products will be furnished on an exchange basis and will be reconditioned or new. All replaced parts and products become the property of **AW-Company**. This limited warranty does not include service to repair damage to the EMO-500 resulting from accident, disaster, abuse, or a **Non-AW-Company** modification to the EMO-500.

Limited Warranty service may be obtained by delivering the EMO-500 during the 1 year warranty period to AW-Company and provide proof of purchase date. If this product is delivered by mail, you agree to insure the EMO-500 or assume the risk of loss or damage in transit, to prepay shipping charges to warranty location and use the original shipping container or equivalent.

For further information contact: **AW-Company**
8809 Industrial Drive, Franksville, WI 53126
Phone: (262) 884-9800
Fax: (262) 884-9810

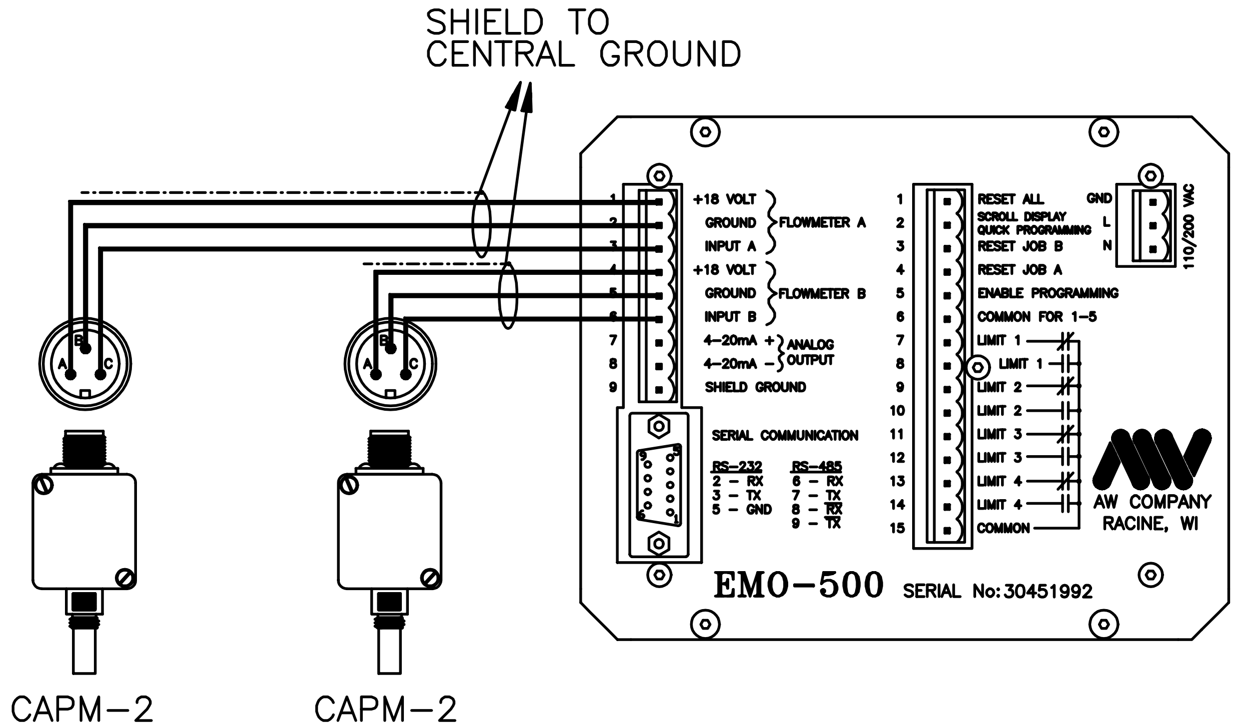
ALL EXPRESS AND IMPLIED WARRANTIES FOR THIS PRODUCT INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO A PERIOD OF 1 (ONE) YEAR FROM DATE OF PURCHASE, AND NO WARRANTIES, WHETHER EXPRESS OR IMPLIED, WILL APPLY AFTER THIS PERIOD. SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE ABOVE LIMITATIONS MAY NOT APPLY TO YOU.

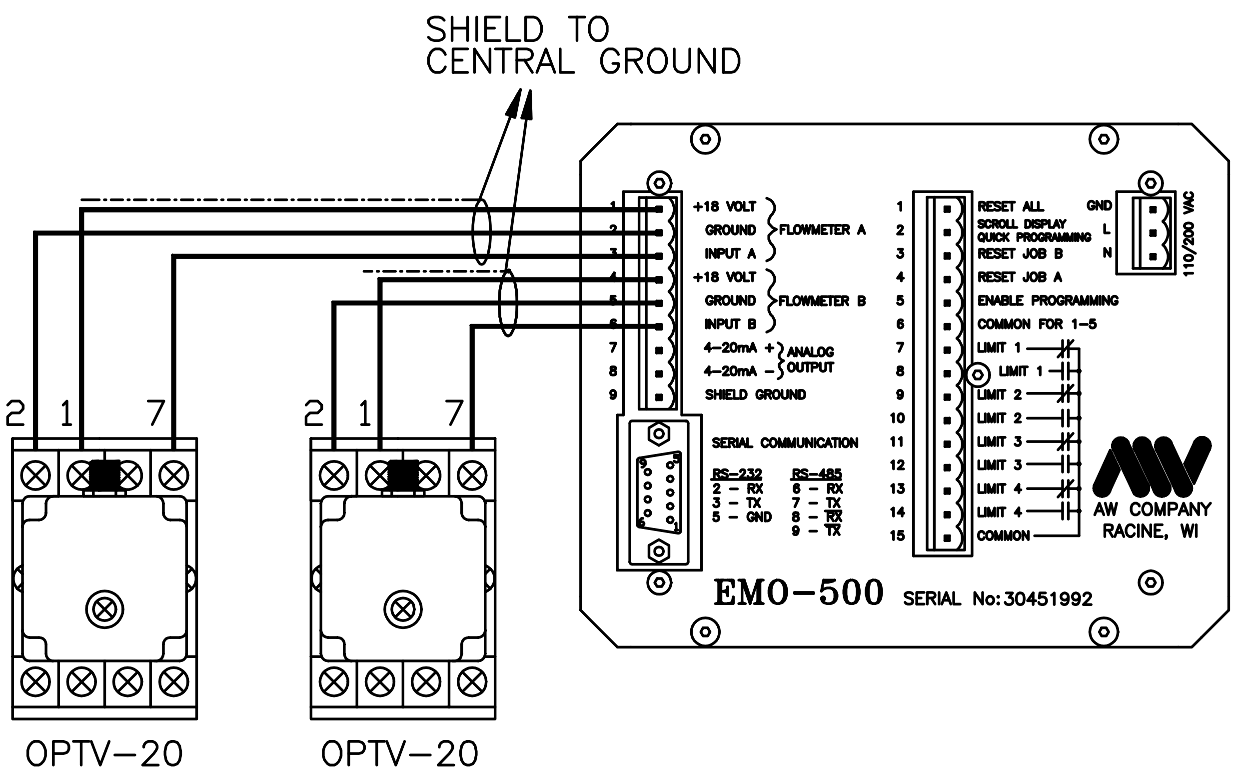
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THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH MAY VARY FROM STATE TO STATE.

EMO-500 SAMPLE CONNECTIONS

PICKUP CONNECTIONS



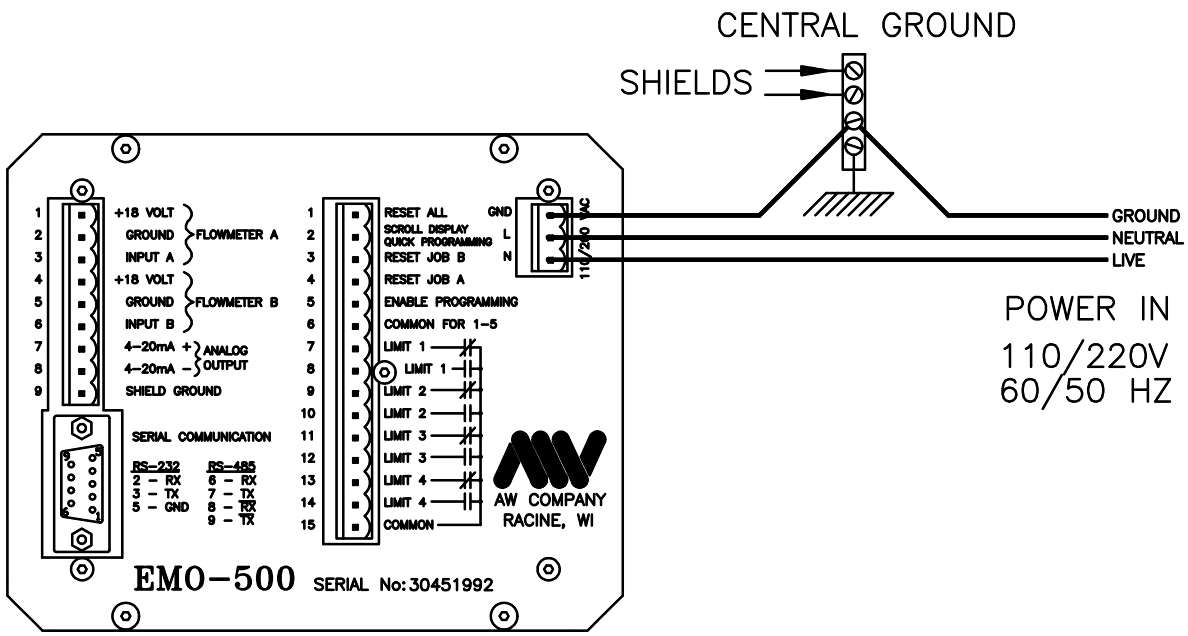


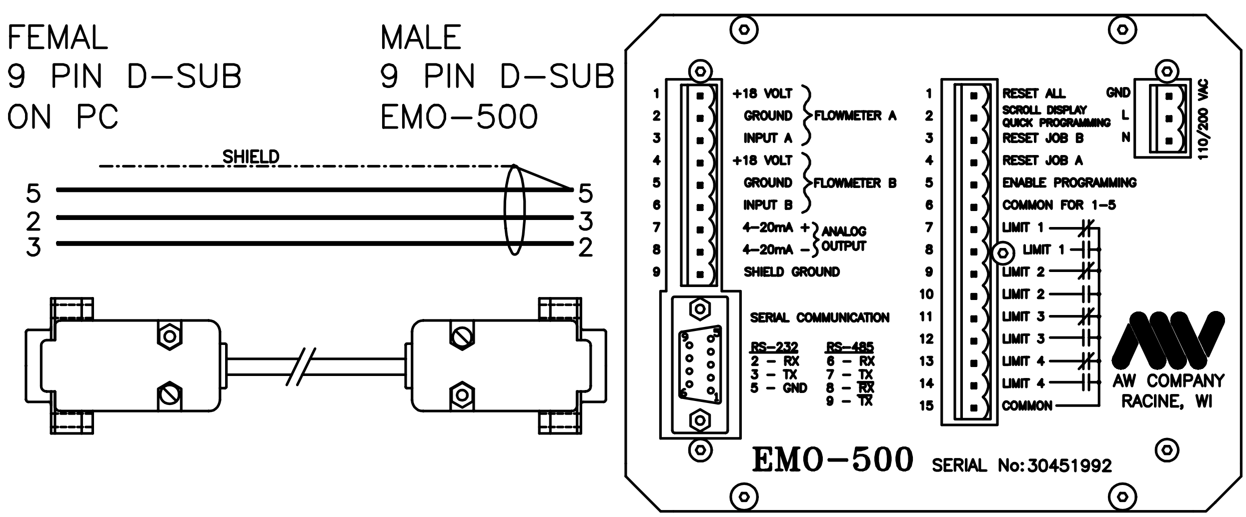
EMO5304B

APPENDIX A

EMO-500 SAMPLE CONNECTIONS

POWER & SERIAL COMMUNICATION



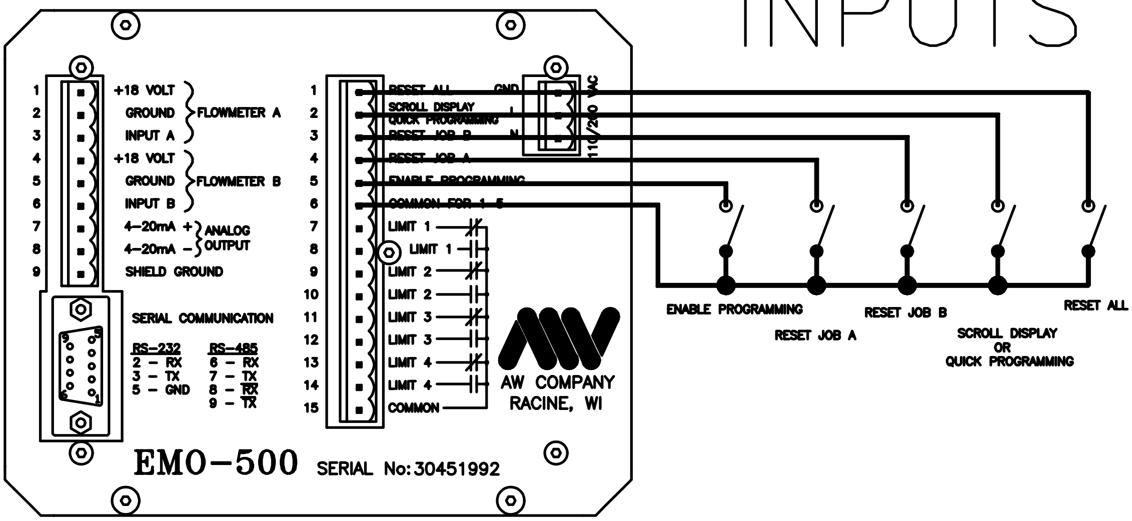


EMO5304B

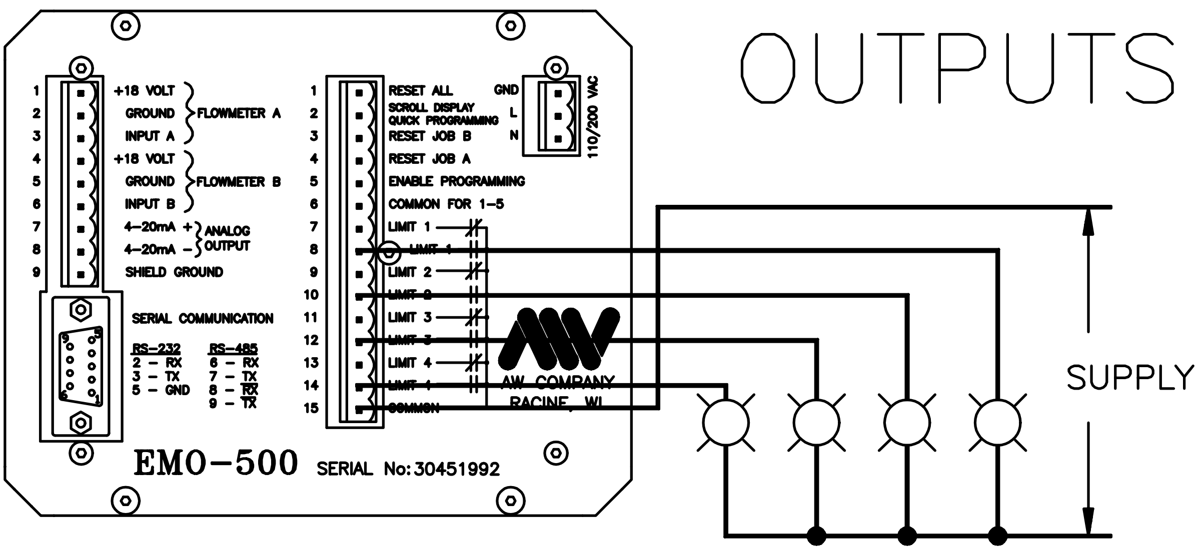
APPENDIX B

EMO–500 SAMPLE CONNECTIONS

INPUTS



OUTPUTS



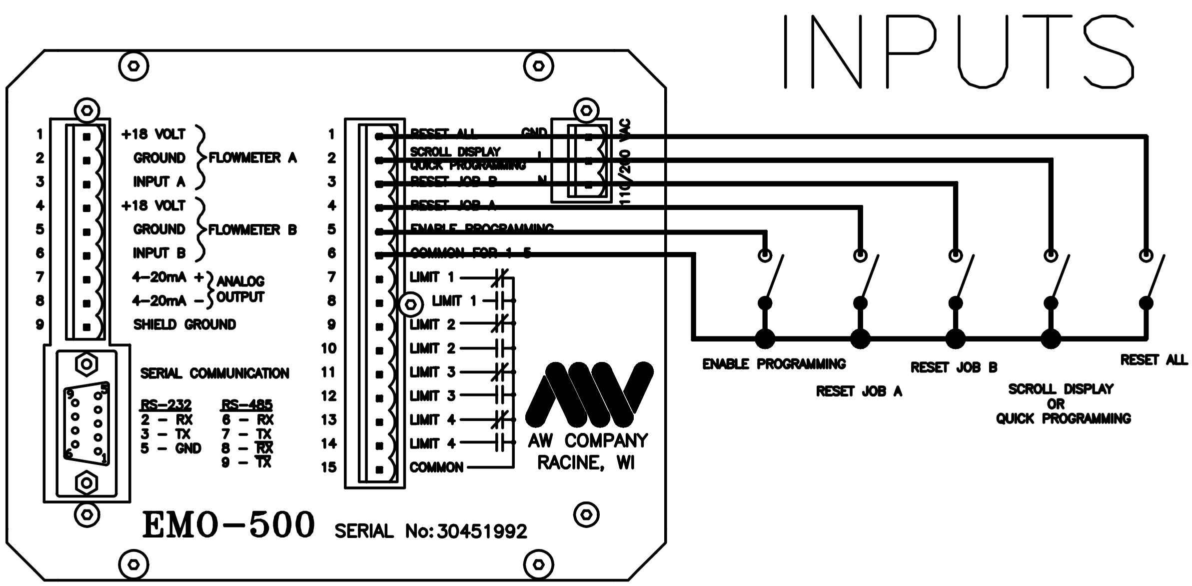
FOR LOAD FROM 1 TO 5 AMP.
USE OUR RHN SERIES RELAYS

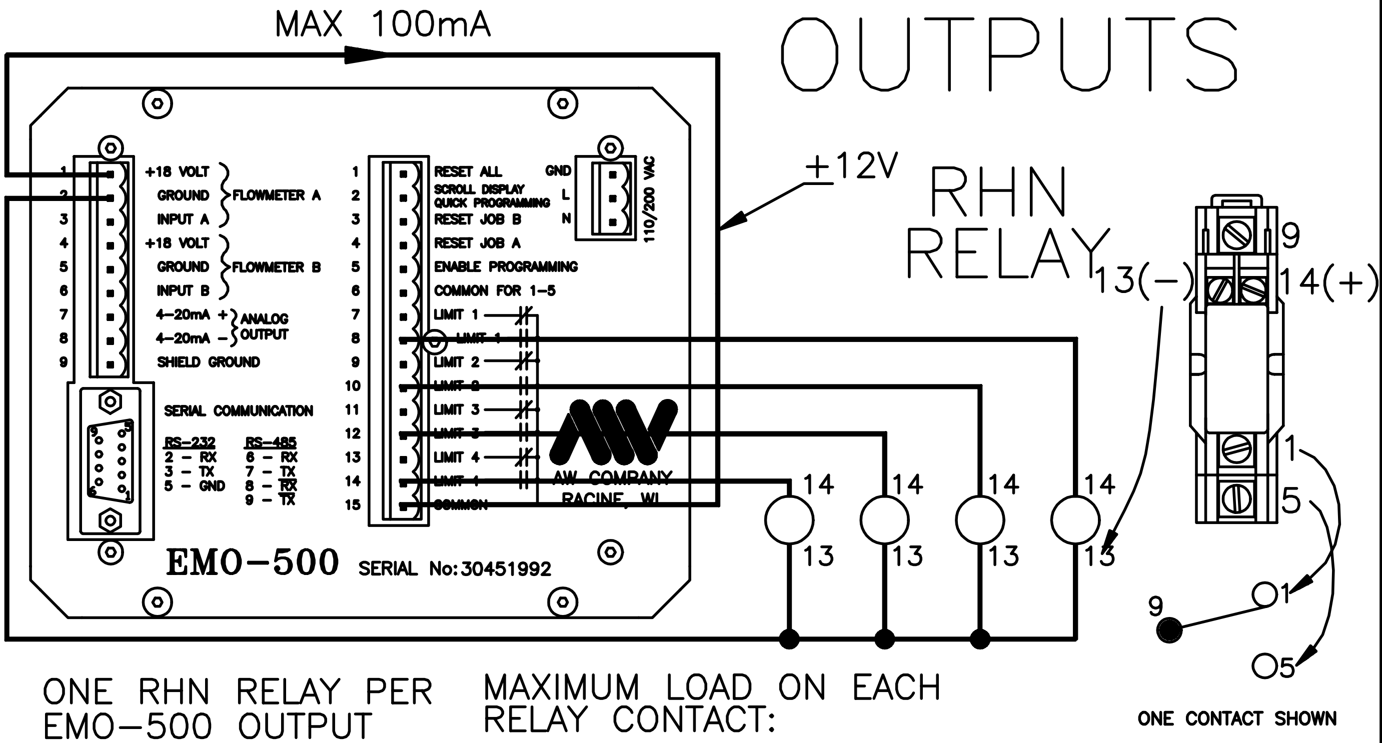
MAXIMUM LOAD PER OUTPUT:
INDUCTIVE: DC:10W – AC:20VA
RESISTIVE: DC:30W – AC:60VA
MAX VOLTAGE: 125 VDC, 125 VAC
MAX SWITCHING CURRENT: 1.25 AMP.

EMO5303B

APPENDIX C

EMO-500 SAMPLE CONNECTIONS





ONE RHN RELAY PER
EMO-500 OUTPUT

MAXIMUM LOAD ON EACH
RELAY CONTACT:
INDUCTIVE: DC:60W - AC:385VA
RESISTIVE: DC:120W - AC:550VA
MAX VOLTAGE: 125 VDC, 250 VAC
MAX SWITCHING CURRENT: 5 AMP

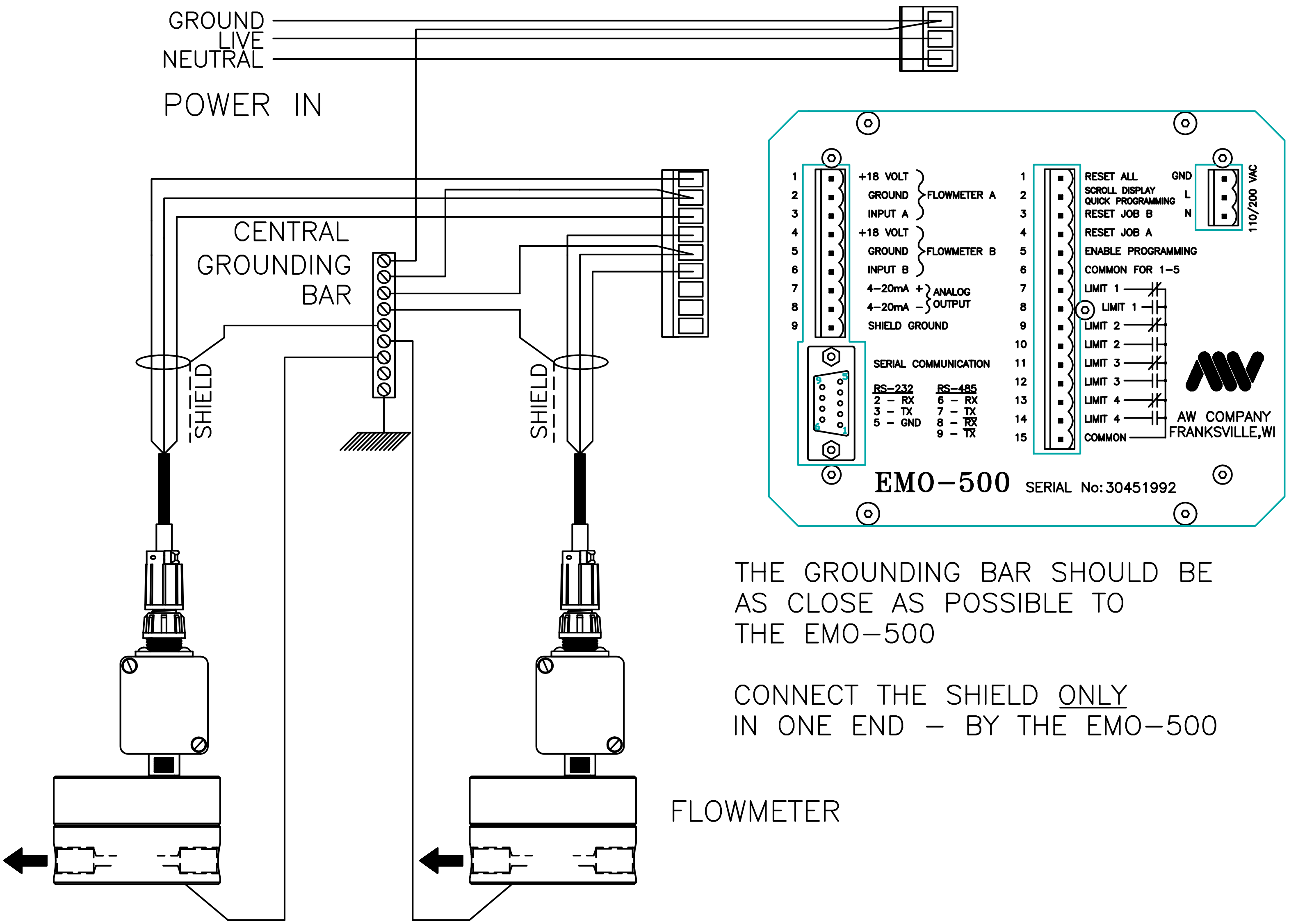
EMO5303B

APPENDIX D

APPENDIX E

EMO-500 GROUND CONNECTIONS

EMO5306A

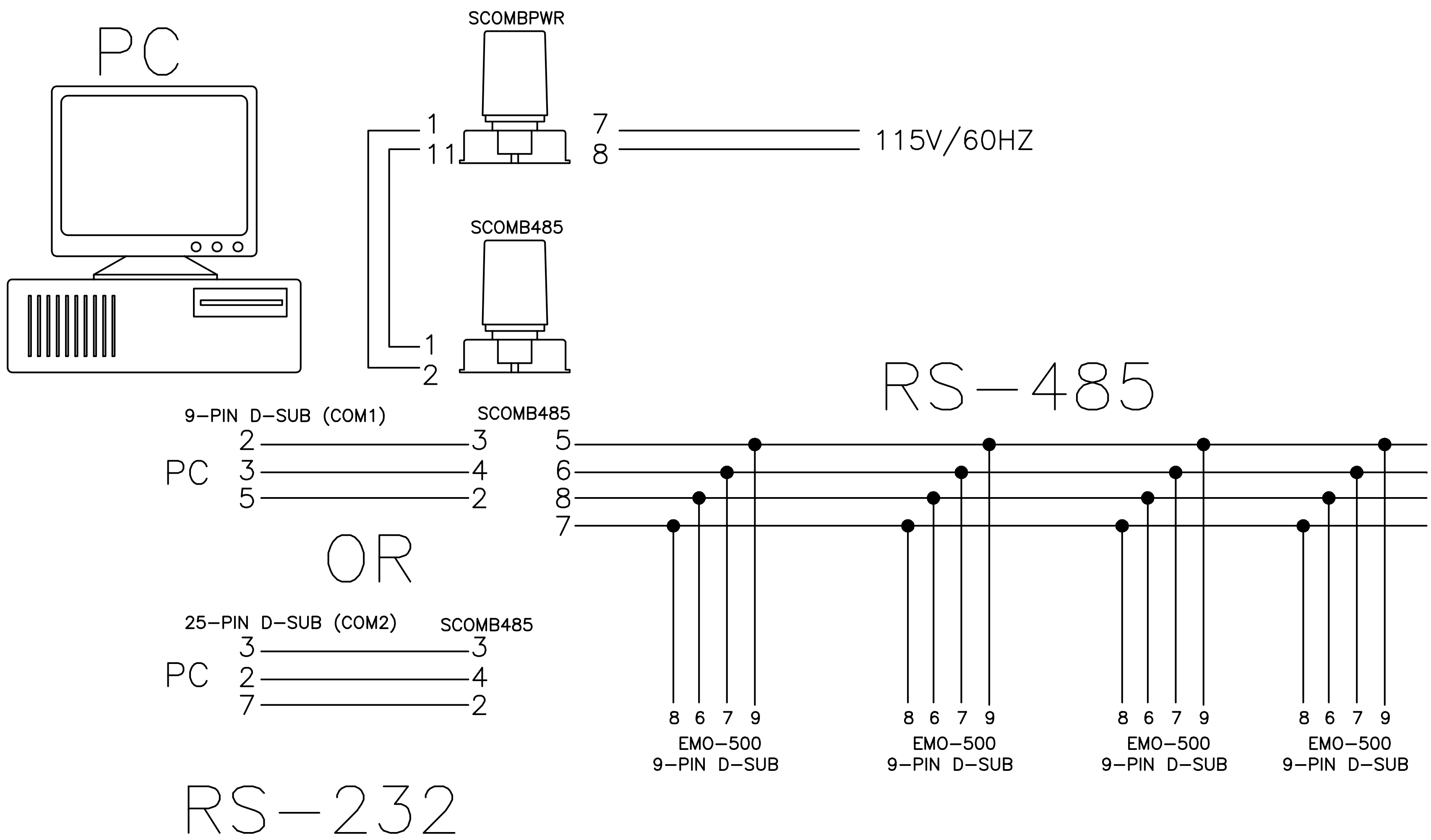


THE GROUNDING BAR SHOULD BE AS CLOSE AS POSSIBLE TO THE EMO-500

CONNECT THE SHIELD <u>ONLY</u> IN ONE END - BY THE EMO-500

RS-485 NETWORK WITH MULTIPLE EMO-500

REV	DESCRIPTION	DATE	APPR.BY
A	INITIAL RELEASE	06-22-94	A.W.

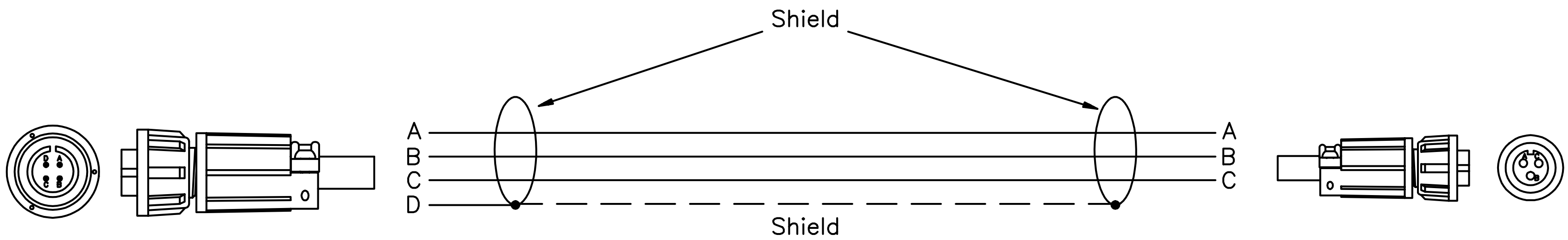


AW-COMPANY
FRANKSVILLE, WI 53126

TITLE: RS-485 NETWORK	
DRAWING NUMBER: SCM4902A	
DRAWN BY: GUS SKIAKER	
DATE: 06-22-94	CHECKED BY: A.W.
PAGE 1 OF 1	SCALE: NONE

EMO-500\E PICKUP CABLE

EMO Side **Pickup Side**



AW COMPANY
FRANKSVILLE, WI 53126

TITLE: EMO-500 PICKUP CABLE			
DRAWING NUMBER: EMO5400A		PART NUMBER: —	
DATE: 7-23-99	REV: A	DRAWN BY: SHANE WILSON	
CHECKED BY: C.H.	PAGE 1 OF 1	SCALE: NONE	